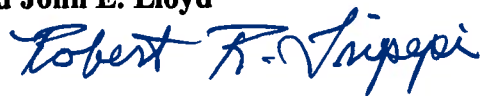


Title: **Holding Bareroot Colorado Spruce Trees in a Gravel Bed**

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YEAR-END STATUS OF THE PROJECT

Materials and Methods:

In this study, balled and burlapped Colorado spruce trees had all soil removed from their root balls, making them bare root plants. These trees were then planted in one of two types of gravel in May 2004. The two gravel beds were 12 ft. long by 16 ft. wide by 1 ft. tall. One bed held a mixture of 88% pea gravel (3/8-inch minus), 2% Turface®, and 10% silica sand (by volume). The other bed contained a mixture of 90% basalt gravel (1/2-inch) and 10% silica sand (by volume). Twelve Colorado spruce (*Picea pungens*) trees that were 1.5 to 1.8 m (5 to 6 feet) tall and had 24-inch root balls were used in this study. Eight of these trees were from the 2002 spruce tree holding experiment, and four of the trees were from the 2003 spruce tree holding experiment. Please see the December 2004 report for additional details about the trees and the cultural practices used while they were growing in the gravel beds. Trees were grown in the gravel during the 2004 growing season and transplanted during September or October last year. Three trees from each type of gravel bed were randomly selected, lifted and planted in a field during both of these two months. Six trees were transplanted in mid-September, and another six trees were moved on October 14. The trees were planted in a randomized complete block design in the field, and their circumference at 5 cm (2 inches) above the soil was measured at the end of October 2004.

The trees were watered four times between June and August 2005. On August 10, trunk circumference was measured (since measuring trunk diameter was inaccurate with the calipers we usually used) at 5 cm above the soil level. In addition, new growth of the terminal leader or the highest lateral branch if the leader died was measured. The trees were also rated for their appearance. The scale used was 1 to 5: 1 was used for a dead tree, 2 was used for a tree with a dead leader, dieback on many branches, and many needles damaged, 3 was used for a tree with a dead leader, some branch dieback and some needle damage, 4 was used for a tree with an intact leader but some minor needle damage, and 5 was used for a tree that lacked any damage.

Analysis of variance was used to determine if the type of gravel affected the mean increase in circumference (comparing trunk circumference from October 2004 to August 2005). Mean increase in trunk circumference was determined as a percentage of the 2004 trunk circumference. The mean increase in tree height growth for 2005 was also analyzed. The overall probability needed to show significant effects from the type of gravel used or transplanting month had to be

at or below the 5% level ($P \leq 0.05$) when completing the statistical analyses. Significant differences between treatments (types of gravel used) or transplant months were determined by Least Squares Means at the 5% level.

Results:

All Colorado spruce trees transplanted to the field in fall of 2004 lived and grew a little during 2005. Neither the type of gravel used ($P > 0.0973$) nor the month the trees were transplanted ($P > 0.6020$) affected height increases of the trees during 2005 (Table 1). Similarly, neither gravel type ($P > 0.5974$) nor transplanting month ($P > 0.9672$) affected increases in trunk circumference by the end of the 2005 growing season. Although trees that were grown in pea gravel tended to grow taller during 2005, the differences were considered statistically insignificant. Tree appearance was not statistically analyzed due to the similarity between the different treatments and months the trees were transplanted. Overall, the trees showed signs of damage, but it tended to be minor. In addition, the older needles on all trees except one recovered most of their green color.

Table 1. Mean height increase, trunk circumference increase and plant appearance of Colorado spruce trees in August 2005 after being grown in a basalt or pea gravel and transplanted in September or October 2004.

Month	Type of Gravel	Mean Height Increase* (cm)	Mean Trunk Circumference Increase* (%)	Mean Tree Appearance*#
September	Basalt	2.4	2.5	4.0
	Pea	7.8	3.1	4.0
October	Basalt	3.2	4.2	3.3
	Pea	4.9	1.1	3.7

* Means represent measurements from three trees.

Tree appearance was rated on a scale of 1 to 5: 1 = dead plants, 2 = dead leader, dieback on many branches, and many needles damaged, 3 = dead leader, some branch dieback and some needle damage, 4 = intact leader but some minor needle damage, and 5 = lacked any damage.

Discussion:

This study demonstrated that Colorado spruce trees that had been grown solely in gravel the previous year could adapt again to soil and grow during the next year. The trees grew slowly during 2005, most likely due to severe transplant shock they suffered the year before from having all soil removed from their roots. Nonetheless, the trees did grow a little and all of them survived the summer with only minimal irrigation. Neither the type of gravel used nor the month

the trees were transplanted affected their growth (Table 1). We suspected that both these factors should have had minimal effects, if any. Trees held in pea gravel tended to grow taller, but more trees would need to be used in another experiment to determine if pea gravel was indeed a better growth medium than basalt gravel.

Significance to the Nursery Industry:

This study clearly showed that Colorado spruce trees can be held in a mixture of gravel and sand to help their root systems recover from severe soil losses. Although the leaders and random branches on some of the trees were damaged due to the stress, the trees recovered in the gravel beds and formed many new roots. Recall that the new root growth in the gravel beds was so thick that it encased a large amount of gravel in most root systems, limiting the utility of this technique for bareroot transplanting. Because the trees readily recovered in the gravel and transplanted again easily to soil, gravel beds may be useful for recovering conifer trees that would be discarded if their root balls break during field harvest at the nursery. Trees that have a broken root ball may need to be held several years until a reasonable growth rate is recovered, but the trees that are currently discarded can be saved, enabling growers to recover their investment in each plant.